SC100100 Unit Outline

Chemistry

Unit 1: The Structure and States of Matter

Abstract

In this unit students examine the nature of gases, liquids, and solids considered as particles. The kinetic theory of matter is presented as a model that explains properties of each state of matter and accounts for changes of state. The kinetic theory describes the motion of particles (atoms or molecules) in matter and the forces of attraction between them. Students learn to describe gases, liquids, and solids on a particle basis and explain what happens during the conversion of these three states of matter, one to another. They also investigate sublimation (e.g., gas turning to solid or solid turning to gas without becoming liquid). Students learn to interpret gas pressures, to describe the nature of a liquid in terms of attractive forces, as well as to differentiate between evaporation and boiling. They learn to recognize how the organization of particles distinguishes solids from gases and liquids. They do a variety of projects related to gas pressures, kinetic theory, and crystalline structures.

Lesson 1 – States of Matter and the Kinetic Theory (SC100101)
In this lesson students examine samples of three states of matter, list the general properties of each state, describe them in terms of shape and volume, and list everyday examples of each state. The students use marshmallows to make models of the movement and arrangement of molecules in a gas, liquid, and solid.

Lesson 2 – Temperature Change and the States of Matter (SC100102)
In this lesson students observe the processes of evaporation, condensation, melting, freezing, boiling, and sublimation. They do a quantitative investigation of the freezing of water, to explore explanations that involve particles.

Lesson 3 – Conservation of Mass during Melting (SC100103)
In this lesson students explore the conservation of mass during changes of state. They investigate whether or not the mass of an ice cube changes during melting. Students explain their findings in terms of molecular changes that occur during melting.

Lesson 4 – Evaporation and Cooling (SC100104)
In this lesson, students explore evaporation. They discover that cooling occurs during evaporation, and apply what they know about molecules to understand this process. Group discussions, readings, and questions help develop students' understanding.

Lesson 5 – Condensation and Conservation of Mass (SC100105)
In this lesson, students explore condensation. They design and perform an experiment to test whether mass is conserved during condensation, then apply what they know about molecules to understand this process. Group discussions and questions help clarify students' understanding.

Lesson 6 – Gas Pressure, Temperature, and Volume (SC100106)
In this lesson students explore changes in matter that are brought about by heating or cooling, primarily changes in pressure and volume of gases. Exploration of the phenomena, class discussions, a student reading, and written questions help students deepen their understanding.

Lesson 7 – Measuring Gas Pressure (SC100107)
Students learn how an aneroid barometer works for measuring air pressure. They also study the historical use of mercury barometers. They discuss the role of pressure systems in weather, interpret weather maps, and make predictions about the weather. Students are assessed on their ability to explain how air molecules affect the operation of an aneroid barometer.

Lesson 8 – The Structure of Crystals (SC100108)
In this lesson, students examine a variety of crystalline solids. Students learn that crystals grow naturally and synthetically. They grow their own crystals and explain why different crystals have different shapes.

Lesson 9 – Snow Crystals (SC100109)
In this lesson, students examine the snow crystal to infer the structure of the water molecule that forms it and the forces among water molecules in ice.

Lesson 10 – Steam Heat (SC100110)
In this lesson, students look at the heat of vaporization as liquid water changes to water vapor and examine the implications of this property for the climate of the planet**.**

Michigan Benchmarks

I.1.HS.2 Design and conduct scientific investigations.
Key Concepts: Types of scientific knowledge—hypothesis, theory, observation, conclusion, law, data, generalization. Aspects of field research—hypothesis, design, observations, samples, analysis, conclusion. Aspects of experimental research—hypothesis, design, variable, experimental group, control group, prediction, analysis, conclusion. Investigations are based on questions about the world.

Real-World Contexts: Any suggested in the Using Scientific Knowledge benchmarks for which students would design and/or conduct investigations.

I.1.HS.3 Recognize and explain the limitations of measuring devices.
Key Concepts: Uncertainty, error, range, tolerances, accuracy, precision.

Tools: Balance, thermometer, measuring tape, ruler, graduated cylinder, electronic measuring devices.

Real-World Contexts: Designing an experiment that uses quantitative data.

I.1.HS.5 Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarification or elaboration, taking alternative perspectives, and defending a position.
Key Concepts: Logical argument, summary, clarification, elaboration, alternative perspectives.

Real-World Contexts: Libraries, technical reference books, Internet, computer software.

IV.2.HS.2 Explain why mass is conserved in physical and chemical changes.
Key Concepts: Atom, molecule, mass.

Real-World Contexts: Common physical and chemical changes, including matter cycles in ecosystems.

V.1.HS.3 Explain how common objects are made from earth materials and why earth materials are conserved and recycled.
Key Concepts: Valuable materials – minerals, metallic ores, iron, copper, aluminum, fuels. Types of resources – renewable, nonrenewable. Conservation, limits, recycling, costs for developing more remote supplies. Manufacturing, refining, mining. Recycling processes – melting, shredding, dissolving.

Real-World Contexts: Manufacturing processes – steel mills, auto assembly lines, paper making; local recycling center for materials, such as glass, plastic, aluminum, steel cans, motor oil;

examples of technical and social means for slowing the depletion of earth's resources, such as developing more fuel efficient cars and mandating their use; disposal in landfills and incinerators.

IV.2.HS.4 Describe energy transformations involved in physical, chemical, and nuclear changes, and contrast their relative magnitudes.
Key Concepts: Potential energy, kinetic energy, heat, light, electrical energy, chemical energy, sound, temperature changes. Original sources of energy: sun, radioactivity. Conservation of energy, conservation of mass/energy: $E = MC^2$.

Real-World Contexts: Common physical, chemical and nuclear changes, including changes of state, burning, electrical decomposition of water, photosynthesis, cellular respiration, fireworks and dynamite, nuclear power, stars.

IV.3.HS.1 Analyze patterns of force and motion in the operation of complex machines.
Key Concepts: Electrical and/or mechanical components of complex machines.

Real-World Contexts: Machines, such as bicycles, automobiles, pumps, electrical motors.

National Science Education Standards

Through the completion of the activities in this unit, students and teachers will meet the following National Science Education Standards:

CONTENT STANDARD B: As a result of their activities in grades 9-12, all students should develop an understanding of

- Structure of the atom
- Structure and properties of matter.
- Chemical reactions.
- Motions and forces.
- Conservation of energy and increase in disorder.
- Interactions of energy and matter.